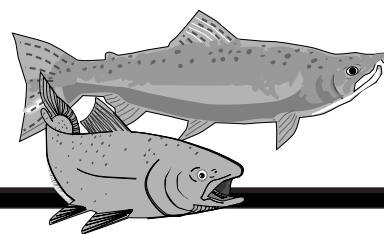


Natural Resources



Natural Resource Management

An Introduction

The purpose of this subject area is to introduce your students to the subject of anadromous fish and provide a basic understanding of natural resources. Since hydropower dams like Bonneville Dam have changed the historic migration routes of salmon, steelhead, shad and other fish species, part of our natural resource management responsibilities include facilitating fish passage past the dam.

The first section includes activities to acquaint your students with the management of natural resources featuring anadromous fish. Next, are self-guided tours of the fish ladders on either side of the river, and the fish hatchery. Also included are charts for your students to use to keep track of the natural resources they might see while at Bonneville Dam. Finally there are activities included to reinforce what has been learned.

History Quickie

Throughout history and prehistory, Columbia River salmon have been harvested in many ways. In the 1870's contraptions known as fishwheels appeared on the Columbia River. These devices worked like waterwheels, capturing fish in scoop-like buckets and depositing them on a boat or platform. The fishwheels worked 24 hours a day and some were very successful, catching as many as 6,000 fish a day. Gill netting and purse seining were even more successful methods of salmon harvest.

Over-harvesting was a major factor in the depletion of the salmon runs. Bonneville Fish Hatchery was built in 1909 to supplement the decreasing fish runs.

Fishwheels were outlawed in Oregon in 1926. The state of Washington followed suit in 1934. There is a model of a fishwheel on display in the Fish Viewing Building at the visitor center on the Washington side of the dam.

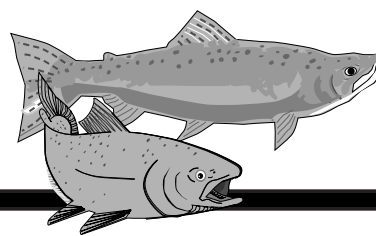
Important Concepts

The activities in this section will help the students understand the following concepts. Important vocabulary words are in bold print.

Natural Resources

A **natural resource** is something found in **nature** that can be useful to people in some way. Humans have the power to change, use, take care of, or destroy natural resources. People also are dependent on natural resources so it is to our benefit to manage natural resources wisely.

A natural resource can be living or non-living. A couple of the non-living natural resources found at Bonneville Dam are water and air. Some of the living resources found near Bonneville Dam are: anadromous fish, osprey, Canada geese, deer and elk.



Natural resources are **interdependent**; they are connected together and interact to form what we call the natural **environment**. When one natural resource is changed it affects all the others.

When we manage natural resources we must think about how a change we make to one resource might affect other resources. We change a river to make hydropower. This change affects other natural resources that depend on the river. We need electricity, irrigation water and river transportation but we also need fish, birds, deer and other animals. Fish, wildlife and plants have adapted to the natural seasonal fluctuations of the river. Building a dam disrupts this natural pattern and steps must be taken to artificially duplicate nature or in some way make up for the harm done. This is called natural resource management.

Anadromous Fish

Because dams effect the migration of **anadromous fish**, the Army Corps of Engineers is highly involved in finding ways to get them around dams safely.

An anadromous fish spends a part of its early life in fresh water (a river, creek or lake), migrates to and grows to adulthood in salt water (the ocean) and then returns to the same river, creek or lake to spawn. These fish are an important source of food for humans and other animals. These fish include salmon, steelhead, shad and lamprey.

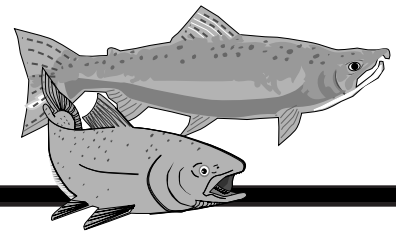
In general, the **Columbia River** salmon's **life cycle** begins in the fall when the adults **spawn** in the same stream bed where they were hatched. An adult salmon can go 900 miles or more inland to spawn in a shallow, clear mountain stream that has a clean bed of gravel. The female makes a nest in the bed of gravel called a **redd**. There she lays her eggs. The male passes over the redd and fertilizes the eggs by releasing **milt** or sperm. Both male and female salmon die after spawning.

The eggs hatch in about six weeks and the little fish live and grow in the stream from 2 to 18 months. The little fish, called **fingerlings**, grow to about the size of a human finger. Fingerlings migrate to sea between the spring and late summer time runoff. A fingerling goes to sea and is called a **smolt**. A smolt's body is changing so that it can live in salt water. This is called **smoltification**.

After the smolts make it to the ocean they will spend one to five years there. Because there is a lot of food in the ocean they become very large. During their rearing time in the ocean, they become adults and instinct tells them they must return to the place where they were spawned. They return to the Columbia River and eventually find their way back to the spawning stream.

Scientists think the fish find their way back to that stream where they were reared by sensing the **chemical composition** of the water. This is much like our sense of smell or taste.

Steelhead and shad also return to fresh water to spawn but do not necessarily die afterward. Their life cycle is similar to salmon except that they can potentially spawn several times. Steelhead spawn in a shallow, clear mountain stream that features a clean, bed of gravel. Shad spawn mainly in the reservoirs (lakes) created by the dams.



Fish Facilities

Fish Ladders

The returning adult fish get around a dam using **fish ladders**. The fish are attracted into the ladders through a series of entrances along the face of the powerhouse and at the edge of the spillway. Water from the lake is added to the ladder water to create a strong flow into the river downstream, which attracts fish up and into the fish ladders. At Bonneville Dam they must swim up 60 steps, each step is 1 foot. Fish ladders were built during the construction of Bonneville Dam.

The fish ladders have been modified several times in the last 50 years. The submerged orifices or holes in the weirs or walls of the ladders were constructed to make it easier for the migrating fish. They no longer have to jump over each of the weirs, they can swim through the holes. The fish ladders now also feature underwater windows where migrating fish can be viewed.

There are four fish ladders at Bonneville Dam. One allows fish to migrate past the first powerhouse and joins one that attracts fish from the south side of the spillway. That set goes past the Visitor Center on the Oregon shore where the underwater windows allow viewing on the first floor. Another allows fish to migrate past the second powerhouse and joins one that attracts fish from the north side of the spillway. This set goes past the Fish Viewing Building on the Washington shore where the underwater windows allow viewing.

Fingerling Bypass

There are four major ways that the Army Corps of Engineers attempts to get juvenile fish migrating to the ocean past dams safely.

Spillway

Water is allocated in the spring to help the smolts on their way to the ocean. Generally, smolt bodies have adapted to migrating to the ocean in close to 30 days. Reservoirs slow their migration which can effect their survival rate.

Water that would normally be saved for use at low water times is passed by dams to increase the flow between reservoirs and speed juvenile fish migration. The water budget is used to bring the flow of the river up to a certain minimum, **but the water can** be passed through the turbines if the resulting power is marketable.

Submerged Traveling Screens

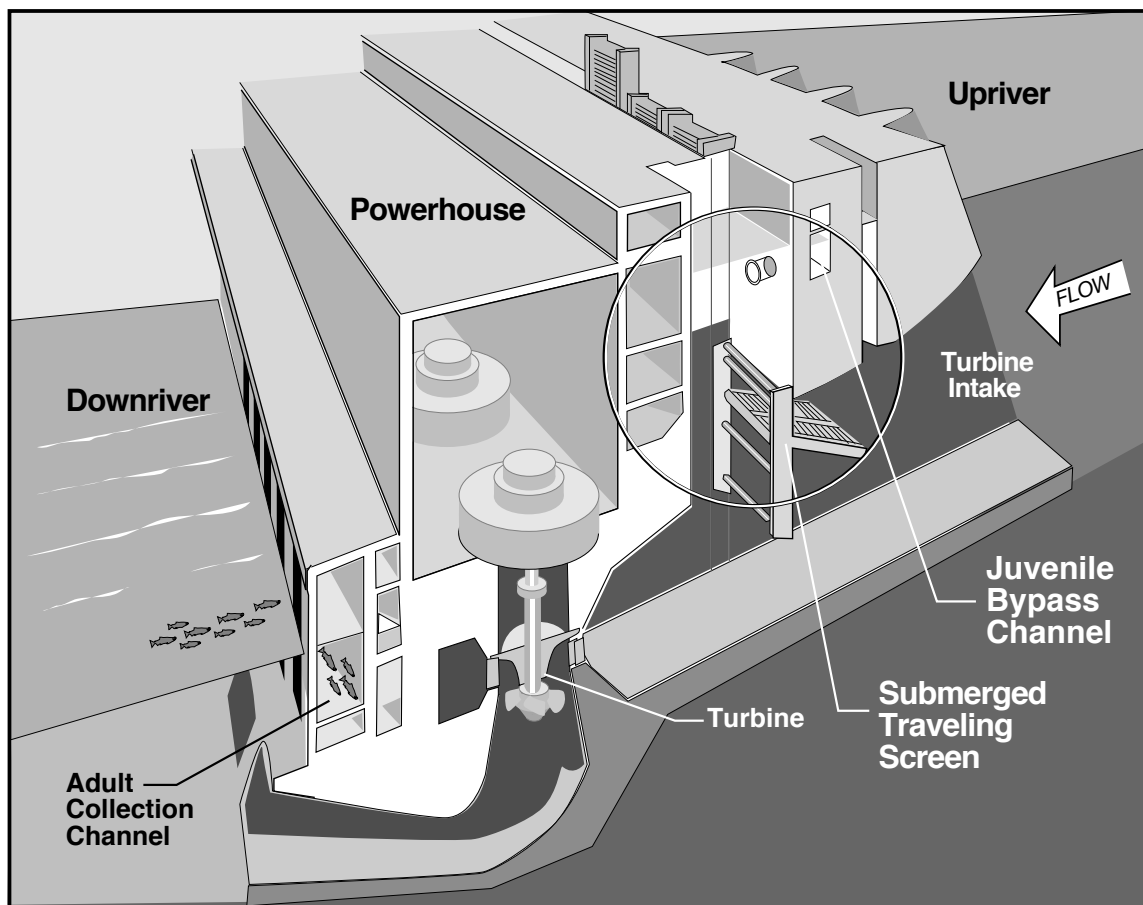
Engineers have designed what are known as submerged traveling screens that are placed near the roof of the intakes (where the water runs through the powerhouse). The screens guide some of the smolts out of the turbine intakes and into the juvenile bypass channel. The juvenile bypass channel is a channel that runs the length of the dam and leads the smolts to the downriver side of the dam.

Juvenile Fish Transport

The Army Corps of Engineers has developed a program of transporting smolts in trucks and barges from collection stations at upstream dams to below Bonneville Dam. This speeds the time it takes the smolts to make it to the sea and avoids the dangers of the dams and lakes.

Hatcheries

The Army Corps of Engineers also helps fund many fish hatcheries. Fish hatcheries supplement the fish that wild runs produce by mitigating for lost spawning ground. Many things have reduced the amount of spawning ground available to the salmon. Access to nearly half of the once available spawning ground was blocked by Chief Joseph dam on the Columbia and Hells Canyon dam on the Snake River. Other factors such as badly engineered logging and road construction, grazing cattle too close to the banks of a stream, pollution, and residential or commercial building destroy spawning grounds by silting in, warming or covering the stream.



Natural Resource Management Before Your Visit

The following fish and natural resource-related activities may be used to prepare your students for a visit to Bonneville Dam.

Activities

Salmon In The News:

Salmon are often in the news. Beginning a few weeks before your visit, ask your students to bring in articles about salmon and other anadromous species. Students who are aware of current events often seem to get more out of their visit to Bonneville Dam. Use a bulletin board in the class for posting the articles. Discuss each article.

Salmon Life Cycle:

Ask your students to draw a representation of the life cycle of a salmon. The drawing may include: eggs, hatchlings, fingerlings, and adults.

Fish Migration Game:

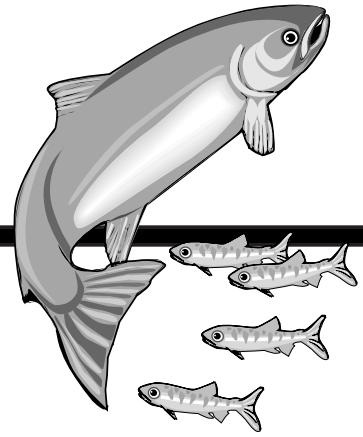
This game can be played either at Bonneville Dam or at the school in an outdoor or large indoor area. It will help students understand the lifecycle of anadromous fish, survival of the fittest and how this supports the food web.

The Anadromous Fish Game:

By playing the enclosed “ANADROMOUS FISH GAME,” your students will become familiar with the life cycle of anadromous fish and they will learn how these fish get past Bonneville Dam.

Natural Resource Identification:

This game will help students to identify what resources are useful to us. Some natural resources are taken for granted because they are so familiar.



Fish Migration Game

Special Requirement!

Because this game involves large amounts of movement, ample space is needed. Play either indoors or outdoors.

This is a three-part activity (with a pre-game discussion, the game, and a post-game discussion) designed to acquaint participants with some of the difficulties encountered by anadromous fish during the migratory phases of their lives and show how the anadromous fish life cycle supports the food web.

In nature, survival of the fittest is an important element in the survival of a species as a whole.

The Pre-game Discussion:

Bring the children together and ask them, “What problems do salmon face as they come up the river?” (Students should be somewhat familiar with the life cycle of salmon or other anadromous fish.) Problems could include anglers, predators, and migrating past dams, etc. Make a similar list of problems affecting juveniles migrating downstream. Predatory birds and fish, passing through turbines at powerhouses and any other problems that the students can think of. This discussion sets the number of variables for the game. Every problem mentioned becomes one of the active roles taken by those who volunteer to play the parts. Each person, or group of people will thus be identified as either young salmon, a dam, predatory fish or birds, anglers, etc.

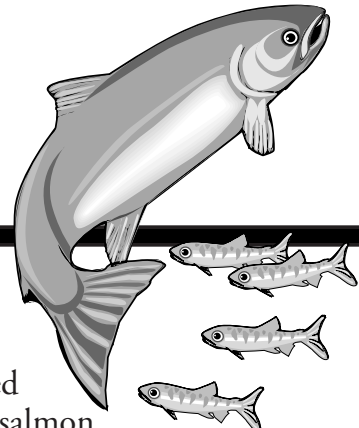
The Game:

Designate a pathway (about 50-100 feet long) as the stream or river. It should lead from the “spawning area” to the “ocean”. Problems (represented by children) should be placed along the pathway in their natural sequence (i.e. predators, anglers, etc.). The rest of the children are the migrating fish.

The young fish should follow the path to the ocean. As they travel, they should try to avoid being caught. A catch requires a touch on the shoulder. If caught, they should sit out the rest of the game and watch what happens. When the surviving young salmon reach the ocean, stop the game, talk about the loss of the juvenile fish and how they support the food web. Also talk about their years in the ocean where predators and ocean trawlers will take their toll and then let the survivors, who are now “adult” salmon, return to the spawning stream. Again, they should travel and avoid problems. At the end of the game there should only be one to two percent of the fish left.

Post-game Discussion:

After the adult salmon have returned to the spawning area, gather the group together to reinforce important concepts by comparing the game to reality.



In reality a very small percent of the salmon will live to spawn. It is important to discuss the salmon life cycle and how it is affected by the problems encountered during their migratory life, how the salmon support the food web, and how survival of the fittest ensures a healthy, strong population of fish.

The Anadromous Fish Game

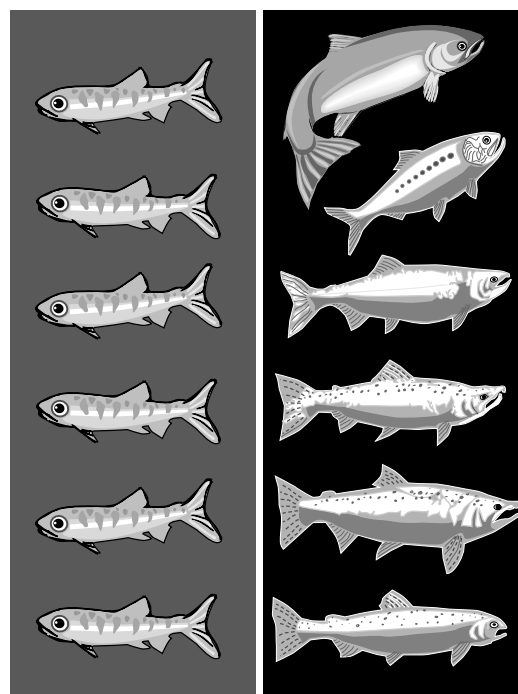
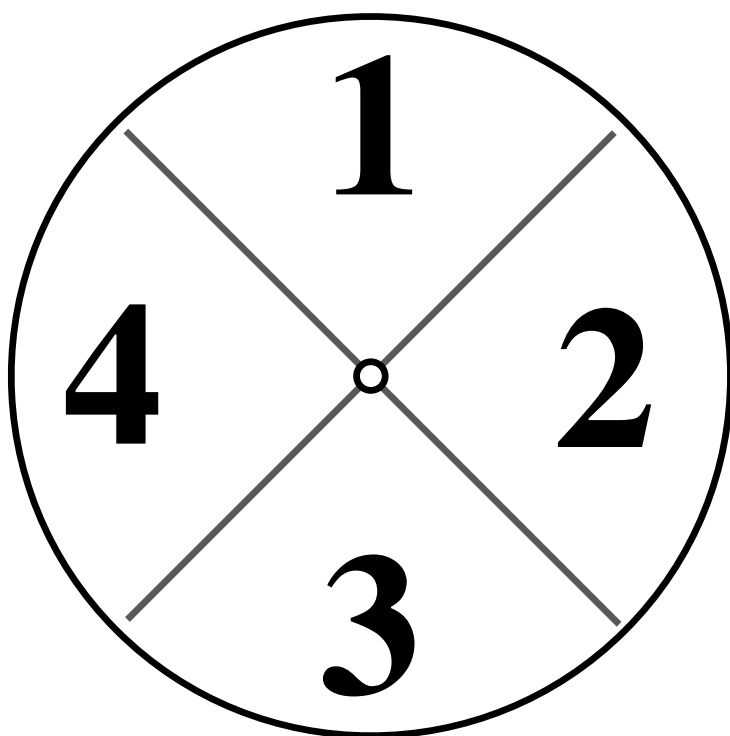
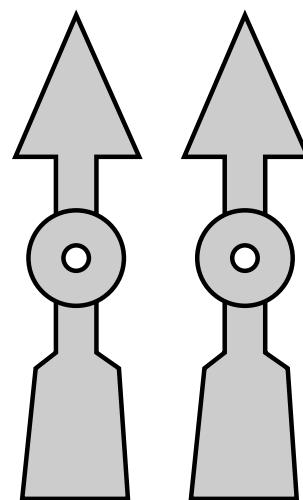
Here's a board game with all the parts and direction provided. Just put it together and have fun!

Directions:

1. Color the game board, arrow, fish, and spinner.
2. Cut them out with scissors.
3. Paste them to cardboard.
4. Attach the arrow to the spinner by piercing the center of both with a pin.

TO PLAY: Each player should spin the spinner once. The highest number goes first, then play in a clockwise direction. Everyone should start in the space marked start. This space is connected to the spawning stream and the hatchery which are two places where salmon are born.

The winner is the first player to move a salmon to the "ocean" and back to either the "spawning stream" or the "hatchery." Good luck!

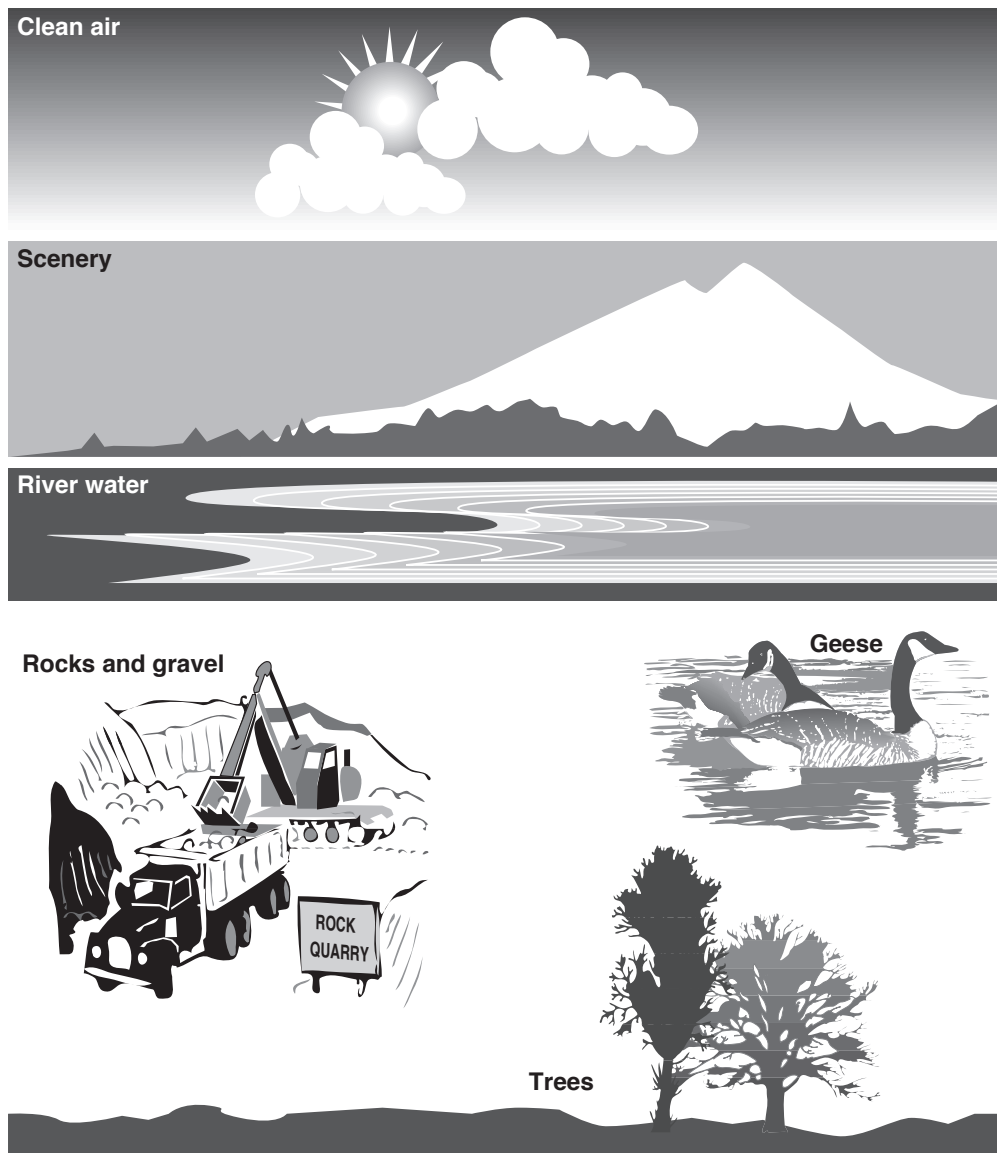


Natural Resource Identification

Natural resources are things in nature that may be useful to us in some way.

Below, you will see drawings of some of the natural resources that the Corps of Engineers takes care of at Bonneville Dam. Under each drawing, write how each of the living or non-living natural resources may be useful to people.

Next, draw lines between any of these natural resources which are connected somehow to one another. For example, geese need water so draw a line from the geese to the water. What other connections are there?



Natural Resource Management During Your Visit

The purpose of this section is to give your students a self-taught learning experience while they are at Bonneville Dam. It includes self-guided tours of the facilities.

Most of the following activities are intended for a specific location. For many, the students will need copies of the activities and pencils.

Activities

On Your Way To The Dam:

Visit other dams and/or fish hatcheries. Stop at some of the many park and recreation lands in the Columbia Gorge to enjoy this spectacular natural area.

Bradford Island Visitor Center:

At the Bradford Island Visitor Center you will be able to view the fish ladder from both above and below water level. Exhibits on the lower floor will inform you about fish passage and life cycles. See the activity titled, Self-Guided Tour of The Fish Ladder at the Bradford Island Visitor Center.”

The Second Powerhouse Visitor Complex:

Facilities at the Second Powerhouse include fish ladder viewing from above and below water level, an exhibit about the history of fishing in the Gorge and exhibits about other aspects of fish migration and life cycles. See the activity entitled, “A Self-Guided Tour of the Fish Ladder at the Visitor Orientation Building.”

The Bonneville Hatchery:

Highlights of the fish hatchery include rearing ponds, in which salmon are raised, sturgeon and trout ponds, where these fish are exhibited, and a building where you can learn how salmon are processed.

Charting Resources And Animal Checklist:

A copy of this game should be given to each of your students. It will help them identify the natural resources at Bonneville Dam and what we have done to use or change the resource. After your visit you can discuss the importance of the resources the students have observed.



A Self-guided Tour of The Fish Ladder Bradford Island Visitor Center, Oregon

Use this sheet to find out how salmon get past Bonneville Dam.

Stop #1: Go To The First Floor Of The Visitor Center

Walk out the door to the right as you face the windows. Walk up the ramp. You will be outside looking at the fish ladders. Walk up them (south) and see if you can pick out each different section.

Walk down the steps to the first floor windows again. The windows you are looking through give you a view into the fish ladder.

Which way are the adult fish going in the ladder?

- ☐ a. with the current
- ☐ b. against the current

Is the fish ladder used mostly by adult fish or juvenile fish? _____

Stop #2: Look At The Models Of The Fish.

Name five kinds of fish seen in the ladder here at Bonneville Dam. Use the models to help you identify the fish you see in the ladder.

1. _____ 2. _____

3. _____ 4. _____

5. _____

Where are the adult fish in the fish ladder going after they are out of the ladders?

- ☐ a. upriver
- ☐ b. downriver

Why do they have to get past Bonneville Dam?

True or False? At Bonneville Dam, fish are counted as they come up the ladder.

- ☐ True
- ☐ False



Stop #3: Look At The Fish Count.

Which fish are counted?

1. _____ 2. _____
3. _____ 4. _____
5. _____ 6. _____
7. _____

Why are the fish counted? _____

Stop #4: Look At The Migratory Patterns Exhibit.

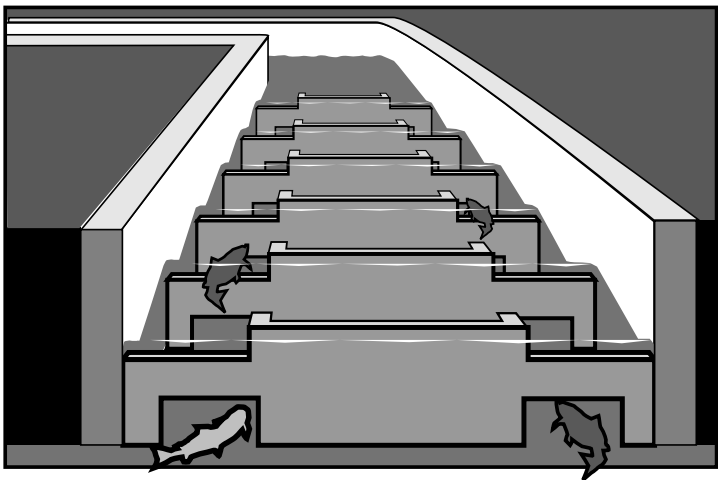
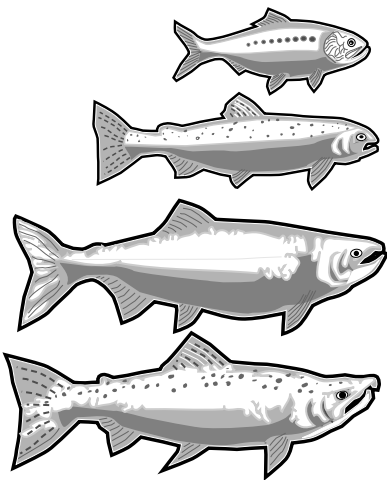
Columbia River Chinook spend _____ to _____ years at sea.

Bonus Question

As you have discovered, the ladders are mostly used by the adult fish going upstream to spawn. The fish going downstream go past the dam in several ways. Can you name two ways, other than the ladders, juvenile fish going downstream get past the dam?

1. _____ 2. _____

If you have questions about the fish or fish ladders, please ask at the information desk on the fourth floor.





A Self-guided Tour of The Fish Ladder Bradford Island Visitor Center, Oregon

Answers:

Use this sheet to find out how salmon get past Bonneville Dam.

Stop #1: Go To The First Floor Of The Visitor Center

Which way are the adult fish going in the ladder?

☐ b. against the current

Is the fish ladder used mostly by adult fish or juvenile fish? **adult fish**

Stop #2: Look At The Models Of The Fish.

Name five kinds of fish seen in the ladder here at Bonneville Dam. Use the models to help you identify the fish you see in the ladder.

1. Chinook salmon
2. coho salmon
3. shad
4. steelhead trout
5. sockeye salmon

Where are the adult fish in the fish ladder going after they are out of the ladders?

☐ a. upriver

Why do they have to get past Bonneville Dam?

Salmon spawn in the same place they were reared which could be hundreds of miles past Bonneville Dam.

True or False? At Bonneville Dam, fish are counted as they come up the ladder.

True

Stop #3: Look At The Fish Count.

Which fish are counted?

- | | | | |
|------------|------------|--------------|-----------------|
| 1. Chinook | 2. coho | 3. steelhead | 4. chinook jack |
| 5. shad | 6. sockeye | 7. coho jack | |

Why are the fish counted?

The fish count helps set regulations, guide hatchery production and assists research.



Stop #4: Look At The Migratory Patterns Exhibit.

Columbia River Chinook spend **two** or **five** years at sea.

Bonus Question

As you have discovered, the ladders are mostly used by the adult fish going upstream to spawn. The fish going downstream go past the dam in several ways. Can you name two ways, other than the ladders, juvenile fish going downstream get past the dam.

1. Many go over the spillway which is opened in the spring.
2. The fingerlings are collected at dams and hatcheries upriver then trucked and barged downriver to be released into the river just below Bonneville Dam.

